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on Influence Factors of Wuhan Housing Industry Based on the AHP

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Abstract

After investigating the present situation of housing industrialization in Wuhan, we sum up the main influent factors of Wuhan city housing industrialization. And applies the analytic hierarchy process (AHP) to establish mathematical model. The model objectively judges various factor of each level through certain quantity of housing industrialization workers, gives the relative importance of every factor in quantitative representation, then calculates the target weights of all factors and finally analyze the results which can be used to provide suggestions for housing industrialization development in Wuhan city.

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Keywords: Housing industrialization development; Influence factor; AHP

1. Introduction

The concept of housing industrialization was first presented in MITI (Ministry of International Trade and Industry) in 1968, which means using industrialized production ways to construct residences in order to improve labor productivity and reduce cost of residential construction^[1]. With China's national economy sustained, stable and healthy development, the housing industry development has gradually become a pillar industry of the national economy. However, Because China's housing industrialization development starts so late and does not have a high level of industrialization, so that it cannot adapt to the needs of the development of national economy in current^[2]. Compared with the developed countries, the low degree of housing industrialization and using the traditional ways to construct houses bring about lower overall efficiency in housing construction. Compared with other Chinese cities, Wuhan housing industrialization development has obviously lagged, and the reasons are various, such as management, technology and market which are needed to be solved immediately. This article uses AHP to study influence factors of Wuhan housing industrialization development. Through the analysis, we conclude the most important factor to control and improve the housing industrialization development in Wuhan.

2. Present situation of Wuhan city housing industrialization development

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2.1. Authentication conditions of component

Currently, Wuhan has not had relevant department of housing industrialization of product certification system. According to relevant state policies and standard, the relative department should make the regulatory documents to put on records of component.

2.2. The development of housing industrialization

Company named Sai Bosi has developed kinds of steel structure housing industrialization projects, such as ‘Sai Bo Yuan’ garden steel structure residential building in Wuhan, ‘golden port’ economy applicable room project, ‘Zi Run Ming Yuan’ steel structure residential building project, and its steel structure housing industrial production base is national housing industrialization demonstration base, and this demonstration base has been able to product and process various steel parts and had made some breakthrough in the research and development of the composite wallboard at present. While ‘Wuhan century garden’ project which is largest steel structure housing demonstration project also has built constructed by Hangxiao construction company.

2.3. Potential industrialization residential market

Wuhan government has built 14 million square meters in 2010. When the buildings are reused to build, housing industrialization promotion is viable. And in recent years, the house prices keep rising so that Wuhan city construction output is from 25.152 billion yuan in 2002 up to 124.602 billion yuan in 2007 at a very fast rate^[3]. The good situation of estate industry testifies that has wide development space of construction market, therefore the market development of housing industrialization is demanded.

2.4. Existing problems

Thought investigating Wuhan builds market and housing industrialization of other cities; we found that although the present situation of Wuhan city housing industrialization started, the speed of development is low and the process of Wuhan city housing industrialization still has some questions:

- Industrialized housing haven't attract consumers enough interest;
- Technologies of the housing industry are still in the lower level;
- Residential industrialization production system has not been formed;
- Core enterprise in industry chain is stunted.

3. Influence factors of Wuhan city housing industrialization development

Based on a large number of literature review and investigation, the influence factors of Wuhan housing industrialization development can be divided into four major categories which are government, enterprise, consumer and market.

• Government

Government leads housing industrialization development in many countries. It can decide the whole building empty where to go through the macro adjustment, therefore the government is a factor cannot be ignored in the process of housing industrialization development. Government plays an important role which will reflect the trend of Wuhan housing industrialization development.

• Enterprise

Enterprise which is principal part includes development enterprise, the construction enterprise, fittings manufacture enterprise, enterprise and so on. Although every company is indispensable in the supply chain of housing industry, Residential development enterprise holds the land resources, directly faces the market, also most likely lead the market, and is the link to connect demand and supply. Thus housing development enterprise is the core enterprise of the entire supply chain. Therefore the altitude which enterprise takes with the housing industry is the key to the housing industrialization development.

• Consumer

Consumer is the final people who will pay for the building products with high technologies. Only does the consumer accept the concept of housing industry, housing industrialization development will have good future. However the enthusiasm consumer looks at the housing industry is not very high. Consequently consumer must be a negligible factor in the future.

- Market

This factor mainly refers to the effects on overall market for the industrialized housing, such as the development of core enterprise, the complete of industrial chain and artificial cost increases which are made by the entire market. It is needed to notice that market has position point: when the other three factors mentioned above in the right direction, market factor also will get better development.

4. AHP model of Wuhan city housing industrialization

4.1. Principle of AHP

Analytical Hierarchy Process, short for AHP, is a multi-objective decision making method which combine qualitative analysis with quantitative analysis and put forward by the American operations research expert T. L. Saaty in the 1970s^[4]. AHP can simplify system analysis and calculation work by structuring, arranging, standardizing and quantifying people thinking process and subjective judgment, so that many uncertain factors are much reduced. Using AHP to solve the complex management problems which are difficult to quantify, we can always get the satisfied results t, thus it's a scientific method of determining the weight^[5].

4.2. Establish AHP structure index system

According to the influence factors of Wuhan housing industrialization development, AHP structure index system can be divided into four layers which are government layer, enterprise layer, consumer layer and market layer, shown in Fig 1.

4.3. Structure judgment matrix

The first layer of housing industrialization influence factors is target layer A, in order to better promote Wuhan housing industrialization development; the second layer is the main factors layer divided parts $\{B_1, B_2, B_3, B_4\}$; the third layer isson factors layer $\{b_{11}, b_{12}, b_{13}, \dots, b_{43}\}$. The assignment scale use 1-9 scale method created by T. L. Saaty by professor. We visit many experts who worked in construction industry including officers, the development enterprises, designers and the constructors, and they analyzed and compared the importance of these factors. Finally, we Structure judgment matrix A, B_1 , B_2 , B_3 , and B_4 , shown in Eq.(1), (2). (3), (4) and (5).

$$A = \begin{bmatrix} 1 & 4 & 3 & 3 \\ \frac{1}{4} & 1 & 2 & 2 \\ \frac{1}{3} & \frac{1}{2} & 1 & 1 \\ \frac{1}{3} & \frac{1}{2} & 1 & 1 \end{bmatrix} \quad (1)$$

$$B_1 = \begin{bmatrix} 1 & 3 & 5 & 4 \\ \frac{1}{3} & 1 & 3 & 2 \\ \frac{1}{5} & \frac{1}{3} & 1 & 2 \\ \frac{1}{4} & \frac{1}{2} & \frac{1}{2} & 1 \end{bmatrix} \quad (2)$$

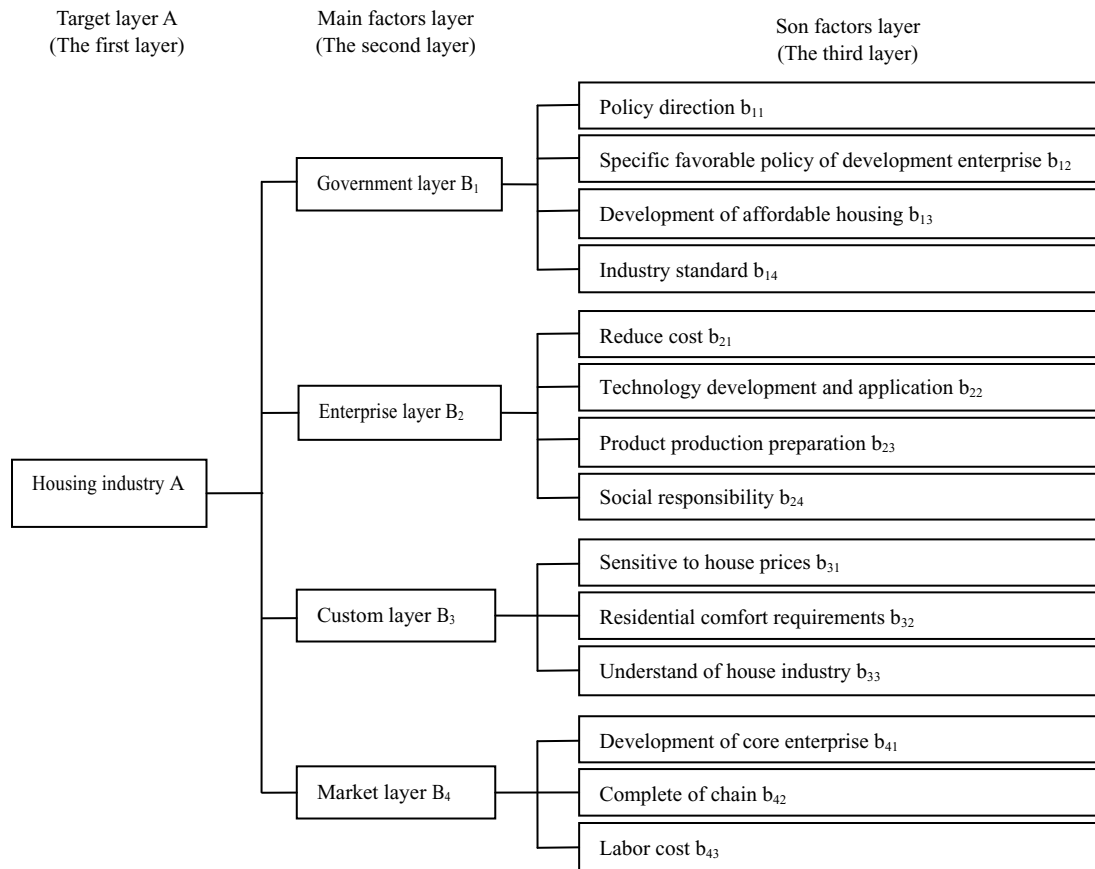


Fig. 1. AHP structure system of housing industry

$$B_2 = \begin{bmatrix} 1 & 4 & 4 & 5 \\ \frac{1}{4} & 1 & 3 & 4 \\ \frac{1}{4} & \frac{1}{3} & 1 & 3 \\ \frac{1}{5} & \frac{1}{4} & \frac{1}{3} & 1 \end{bmatrix} \quad (3)$$

$$B_3 = \begin{bmatrix} 1 & 3 & 5 \\ \frac{1}{3} & 1 & 3 \\ \frac{1}{5} & \frac{1}{3} & 1 \end{bmatrix} \quad (4)$$

$$B_4 = \begin{bmatrix} 1 & 4 & 5 \\ \frac{1}{4} & 1 & 2 \\ \frac{1}{5} & \frac{1}{2} & 1 \end{bmatrix} \quad (5)$$

5. Analysis of calculated results

5.1. Single sort weights level and consistency check

Corresponding to Judgment matrix A, the maximum eigenvalue is λ_{\max} and the characteristic vectors is ω , after

normalizing ,the element is the relative importance sorting weights of all factors for the upper layer some factor. Next we use relative software to solve out each eigenvalue of judgment matrix ω , maximum eigenvalue λ_{\max} , consistency index CI and consistency rate CR ,then check their consistency.

The maximum eigenvalue λ_{\max} of judgment matrix A is 4.1218, and the corresponding normalized feature vector is shown in Eq.(6).

$$\{a_1, a_2, a_3, a_4\} = \{0.5181, 0.2115, 0.1352, 0.1352\} \quad (6)$$

The consistency index CI is shown in Eq.(7).

$$CI = \frac{\lambda - n}{n - 1} = \frac{4.1218 - 4}{4 - 1} = 0.0406, n=4 \quad (7)$$

The corresponding consistency data RI5 is shown in Eq.(8).

$$RI_5 = 0.90 \quad (8)$$

The consistency rate CR is shown in Eq.(9).

$$CR = \frac{CI}{RI} = \frac{0.0406}{0.90} = 0.0451 < 0.1 \quad (9)$$

We conclude that A passes the consistency check.

Also, we use the same step to judgment matrix B_k ($k=1, 2, 3, 4$) and the result is shown in Table.1.

Table. 1 Level sort and consistency check of B_k

k	ω_{k1}	ω_{k2}	ω_{k3}	ω_{k4}	$\lambda_{k \max}$	$CI_k = \frac{\lambda_{k \max} - n}{n - 1}$	RI_k	$CR_k < 0.1?$
1	0.5482	0.2343	0.1190	0.0985	4.1621	0.0540	0.90	0.060 < 0.1
2	0.5566	0.2449	0.1316	0.0669	4.2543	0.0848	0.90	0.094 < 0.1
3	0.6370	0.2583	0.1047	—	3.0385	0.0193	0.58	0.033 < 0.1
4	0.6833	0.1998	0.1168	—	3.0246	0.0123	0.58	0.021 < 0.1
B_k ($k=1, 2, 3, 4$) passes the consistency check.								

5.2. Weights of hierarchy total sort

Finally, we need to draw the lowest layer of the target weights factors in order to determine the influence of housing industrialization development key indicator.

The weight of four factors of the second layer $\{B_1, B_2, B_3, B_4\}$ to the total target A is shown in Eq.(10).

$$\{a_1, a_2, a_3, a_4\} = \{0.5181, 0.2115, 0.1352, 0.1352\} \quad (10)$$

We use software to calculate the each weight of the third layer $\{b_{11}, b_{12}, b_{13} \dots b_{43}\}$ to the total target is shown in Eq.(11) and Fig 2.

$$\omega = (0.2841, 0.1214, 0.0617, 0.0501, 0.1177, 0.0518, 0.0278, 0.0141, 0.0861, 0.0349, 0.0142, 0.924, 0.270, 0.0158)^T \quad (11)$$

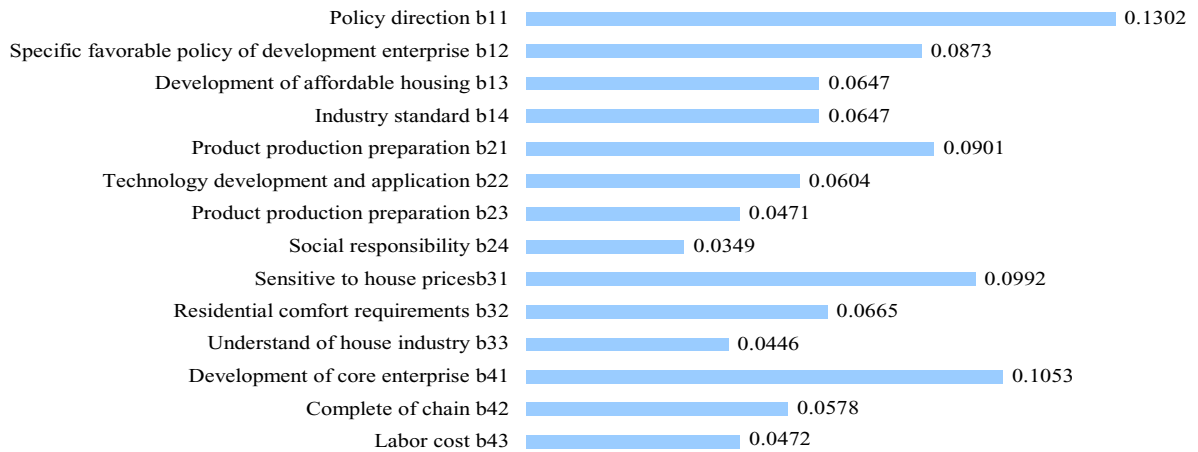


Fig. 2. Weights of all factors of Wuhan housing industry

5.3. Consistency check of hierarchy total sort

Although all levels have been through single sort consistency check and the judgment matrix already has more satisfactory consistency. However nonuniformity of all levels is still possible to build up which will cause worse. Therefore, total sort of high consistency check should be done from low-level step by step, shown in Eq. (12).

$$CR = \frac{a_1 CI_1 + \dots + a_4 CI_4}{a_1 RI_1 + \dots + a_4 RI_4} = \frac{0.5181 \times 0.0540 + 0.2115 \times 0.0848 + 0.1352 \times 0.0193 + 0.1352 \times 0.0123}{0.5181 \times 0.9 + 0.2115 \times 0.9 + 0.1352 \times 0.58 + 0.1352 \times 0.58} = 0.062 < 0.1 \quad (12)$$

We conclude that hierarchy total sort pass the consistency check.

5.4. Analyses of calculation data

From Fig.2, we conclude that government layer ranks first and the weight of government is so larger, which halves the total weight, in which the weight value of policy is the highest. Enterprise layer takes second place, next is consumer layer and market layer followed. And consumer layer and market layer have the same weight value. In enterprise layer, consumer layer and market layer, the factors involving the money have relative larger weight value.

6. Conclusions

Government, enterprise, consumer and market are the key four factors of housing industrialization development in Wuhan through the analysis and investigation, furthermore we establish AHP structure model of influence factors to decide which factor is the most important one. From the result of the weight output of the total target, we can know that the influence of government is the biggest what applies with the current trend of the housing industry development in many developed countries. Consumer takes second place, and market is next. Although market and enterprise is ranked third and fourth, their force cannot be ignored. Among 14 son factors, the weights of son factors involving the cost price is larger and housing industrialization promotion at present prove it what makes this happen is largely due to the high price of the product. Therefore, if Wuhan housing industrialization development wanted to be promoted better, the government should bear the responsibility to guide enterprises and consumer and market to work together to have positive effects.

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